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Manifestly it must stop in the afternoon, as the sun's heat decreases; and it can never occur at night, for then the surface-air is, as a rule, cooler than that above, and the atmospheric equilibrium is correspondingly stable. Further, the whirl will remain at one place, unless, as is often the case, it is carried along by a general motion of the upper air.

There is a very strong point of evidence, if any is needed, in favor of the view that heat applied to the lower layers of the air will produce a whirlwind. This is the fact of their pro-

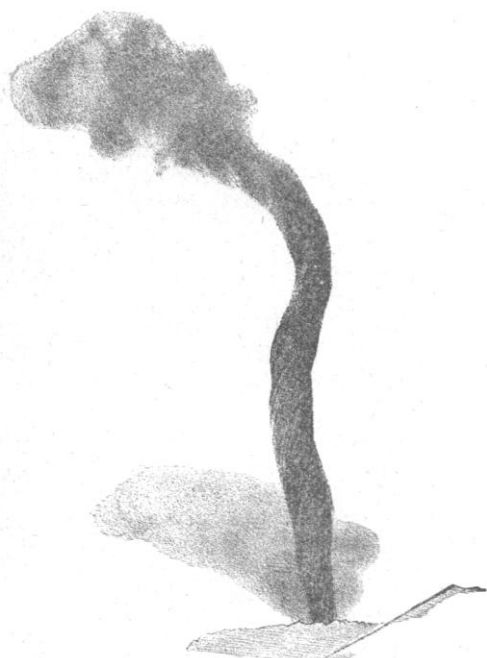


FIG. 4. (Taken from *Abhandl. gesellsch. wiss. Gött.*)

duction over fires. Much interest was excited in this question in connection with the artificial causing of rain, some forty years ago, in this country; and observations were carefully made of the whirls formed over burning woods and canebrakes, showing them to be very similar in form and action to those naturally arising on dry plains (fig. 3). Similar whirls have been seen over volcanoes (fig. 4); and on a calm day the smoke ascending from a factory chimney may be seen to have a slow rotatory motion. Heat is therefore an amply sufficient cause of such disturbances. No other excitement is needed, and electricity has no essential part to play. In recognizing this, we see the chief difference between the older and newer theories of storms.

Sand-whirls are common in all desert or dry regions, where they often have the name of spirits or devils, from the fantastic and apparently evil way in which they flit across the burning sands. They have neither clouds nor rain. When well and frequently developed, they may grow to dangerous strength, and lift much dust and sand into the upper air, where it is blown long distances before falling. In this way they serve as important geologic agents. Vessels west of the Sahara, or east of China, are thus often powdered over with fine dust slowly settling down after a long flight from its desert source.

The smaller water-spouts, doubtless, belong near here in our scheme of classification; but as they are usually aided by vapor-force, and approach the character of tornadoes, their consideration is best deferred till later.

Finally, before going on to the larger storms, one point of much importance must be emphasized. The change from the stable equilibrium of night and early morning to the unstable of noon is effected entirely by the sun's heat, which warms the lower air, and causes it to expand. In expanding, it lifts all the upper air that rests on it; and this is no small piece of work, for the air that is lifted weighs about a ton over every square foot. When a point of escape is found, the heavy upper air sinks again, as the expanded air is drained off (upwards) at the centre. It is this gravitative force of the sinking air-mass that causes the dust-whirlwind, in re-arranging the disturbed equilibrium of the atmosphere; but gravity would have no chance to show its strength, if the air had not been lifted by force from the sun. The winds of a dust-storm, therefore, depend on gravitative force brought into play by the sun's heat. All storms and all winds have more or less closely this relation to solar energy and terrestrial gravity.

(To be continued.)

#### THE INTERNATIONAL FISHERIES EXHIBITION.—FOURTH PAPER.

ON the 1st of October, at noon, the number of visitors to the exhibition passed the much desired limit of two millions; and, although the rainy season had set in, the daily average of attendance was still increasing. The financial success of the enterprise was more than certain two months ago; and the receipts of each day since have been swelling the surplus fund, the disposal of which is now a fruitful subject of discussion in England. Although the organization is a private one, the character

of the men in control of it, and the recognition granted by the Queen and the Prince of Wales, render it certain that the profits will be devoted to some public enterprise. In the midst of multifarious minor propositions, two plans are receiving serious support. One of these is that first brought forward by Professor Ray Lankester, in his address upon 'The (possible) scientific results of the exhibition,' and relates to the establishment of a laboratory of marine zoölogy in Great Britain, for the joint advantage of fisheries and science. Professor Lankester's original memorial was signed by sixteen leading men of science, and has since had the indorsement of the British association. The rival scheme relates to the establishment of an orphanage for fishermen's children; and this, as may be imagined, is much more popular among the people and their newspaper exponents. One influential trade-journal expresses itself in energetic fashion in a paragraph which I cannot refrain from quoting, since it shows how little the opinion of a large class of Englishmen has been acted upon by the leaven of scientific thought. Speaking of the meeting of the British association, the editorial proceeds:—

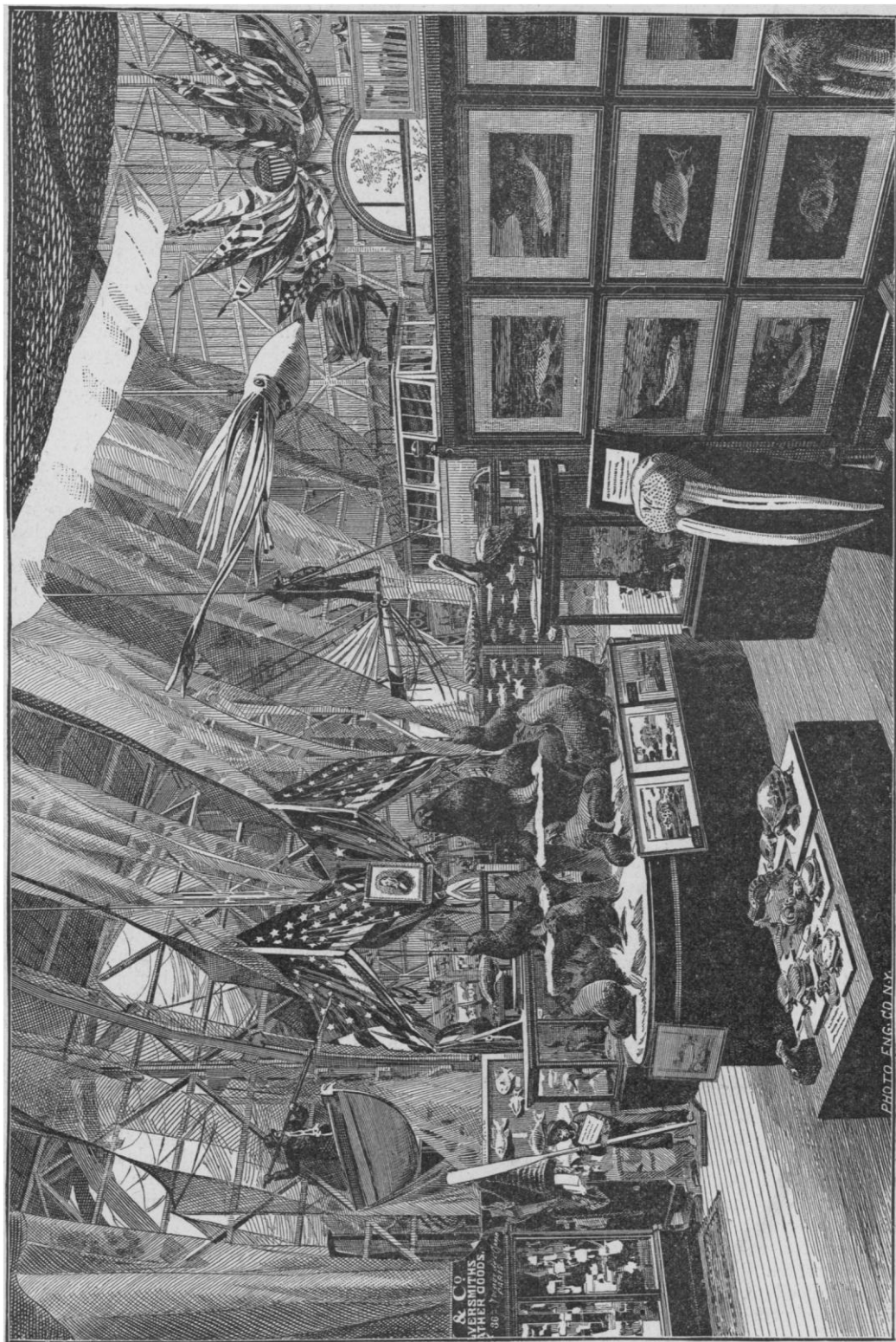
"The conductors of the daily prints, always very amiable to the promoters of these useless gatherings, fool the *savants* to the top of their bent by reporting the 'papers' and discussions at an absurd length, thus making the credulous 'scientists' believe that the public takes a lively interest in their proceedings. . . . It is [the president's] grim task to write an 'address' usually so wildly mystifying as to drive his hearers and readers to the verge of idiocy. By common consent, this year's presidential address was not only more bewildering than any previously delivered, but absolutely incomprehensible; and it is charitably hoped that the Southport meeting is the beginning of the end. But these dreamy gentlemen are sufficiently wide awake to their own interests. . . . This they are, of course, entitled to do; and, if they can squeeze any money out of the public or out of the government, to aid them in the pursuit of their 'fads,' we shall have nothing to say. When, however, they go to the length of proposing to get a portion of the fisheries exhibition surplus into their hands for the purpose of establishing 'a marine zoölogical station on the English coast,' we take leave to denounce such a proceeding as both audacious and preposterous," etc.

In the mean time the executive committee makes no promises, except in the proposition to expend the sum necessary to bring over a Cape-Ann schooner, with a selected crew of fishermen, to demonstrate the American methods of fishing with purse seine, deep-sea trawlines, and dories, on those parts of the British coasts in which their use may be practicable. If any precedent is required for devoting a part of the proceeds to scientific ends, they

have only to look to the Edinburgh exhibition of 1882, the surplus of which to the amount of nearly eight thousand dollars has been given to establish a marine laboratory near Edinburgh, under the direction of Mr. John Murray of the Challenger, and others. It is to be hoped that the demands of science will be remembered. Charities of all descriptions flourish luxuriantly in England, but the workers in science seem to feel that their needs are often seriously neglected.

The amount of the surplus is variously estimated at from forty thousand to a hundred and fifty thousand dollars. The management is not satisfied with the present success, however, and has leased the grounds for three years more from the commissioners of the exhibition of 1851, who, it will be remembered, bought with the surplus of that great enterprise those tracts of land now so valuable, on which all the museums and schools of science and art in South Kensington are now placed. Three great international exhibitions, similar in plan to the fisheries exhibition, are to follow, year by year; and by the end of 1886 the buildings will have more than paid for themselves, and a substantial sum will have accumulated, to be used, perhaps, in continuing the exhibition and museum movement which England has found to be so valuable to its intellectual and industrial welfare. The character of these exhibitions has not yet been determined upon. That of 1884 would doubtless have been devoted to horticulture, floriculture, and forestry, had not Scotland pre-occupied the field with a similar undertaking, and already secured the patronage of royalty. Edinburgh will therefore have its 'international exhibition of objects relating to practical and scientific forestry and forest products' next year; and London will follow in 1885 with a forestry exhibition, which cannot fail to be of world-wide importance. The London fisheries exhibition of 1883 gained much through the experiences of similar exhibitions in Norwich in 1881, and Edinburgh in 1882. The subject of the London exhibition of 1884 is not announced, but it is very possible that it will have to do with food-products. Another programme, hinted at by the Prince of Wales in his speech at the close of the exhibition, provides for a hygienic exhibition in 1884, one of the progress of invention in 1885, and in 1886 an exhibition of colonial products.

The literature of the exhibition is one of its most important features. Almost every subject connected with marine zoölogy and the technology of fishing has been discussed in at



AMERICAN SECTION OF THE INTERNATIONAL FISHERIES EXHIBITION IN LONDON.

least one special essay. The papers published by several foreign governments have been of great importance, particularly the treatises by Grimm, upon the fishes and fisheries of Russia, and by Apostolides, upon those of Greece. Those issued officially by the exhibition have been numerous, and, if the truth must be told, by no means of equal merit. None, however, are without value; and several, especially those by Huxley, Levi, Hubrecht, Lankester, and Day, are important contributions to science.

The official catalogue, edited by Mr. A. J. R. Trendell of the South Kensington museum, well known in America as the secretary of the British commission to our exhibition in 1876 at Philadelphia, is in itself a contribution to knowledge, and a model for the guidance of future exhibition administrations. Each section is introduced by an essay by some recognized authority, and signed. Much serious work has been done by the English periodicals in recording the teachings of the exhibition. *Nature*, under the head of 'Zoölogy at the fisheries exhibition,' has had a review of the vertebrates by Professor Giglioli, and of the invertebrates by Professor Ray Lankester; also a paper on the present state of fish-culture as illustrated at the exhibition, by Mr. Earll. The birds have been considered by Mr. Howard Saunders in the *Ibis*, and by Mr. J. E. Harting in the *Zoölogist*. Mr. Gwynn Jeffreys described the molluscan collections in the *Annals and magazine of natural history*. Mr. Dunell, Mr. W. B. Tegetmeier, Mr. Senior, and others have reviewed the technological features in the *Field*, and Mr. Fell Woods, the oyster-collections in *Land and water*; while *Engineering* has had an elaborate series of illustrated papers upon the vessels and scientific instruments, devoting several numbers to describing the U. S. steamer Albatross and its equipment, and to American devices for the exploration of the depths of the sea.

An official review, elaborately illustrated, of the exhibition and its teachings, is being prepared for the British government by Hon. Spencer Walpole, governor of the Isle of Man, well known as the colleague of Huxley and Buckland in the various fishery commissions from time to time instituted by Parliament.

Nearly every European government has sent hither specialists to report upon special subjects. Among the most eminent of these men of science have been Dr. Steindachner of Vienna, Dr. Sauvage of Paris, Dr. Möbius of Kiel, Professor Benecke of Königsberg, Professor Hubrecht and Dr. Van Bemmelen of Utrecht, Professor Giglioli of Florence, Dr.

van Grimm of St. Petersburg, Dr. Malmgren of Finland, Professor Torell of Stockholm, Dr. Buch of Christiania, Mr. E. P. Ramsay of Sydney, Capt. Comerma of the Spanish navy, and Col. Sola of Madrid. The reports yet to be published will perhaps swell the literature of the exhibition to double its present bulk, and will be of interest to investigators in every department.

The exhibition was formally closed on the 31st of October by the Prince of Wales, who in his speech upon this occasion made certain very fitting allusions to the work of his father, Prince Albert, in the promotion of international exhibitions. G. BROWN GOODE.

#### A FOUR-DAYS' CRUISE OF THE ALBATROSS.<sup>1</sup>

WE left Wood's Holl at 4.10 P.M., Sept. 29, for an offshore dredging-trip. The weather was clear and pleasant, with light southerly winds and smooth sea.

At 9.02 A.M. the following day, we sounded in 1,342 fathoms, — bottom, globigerina ooze; latitude 39° 29' north, longitude 70° 58' 40" west, — and at 9.38 put over the beam-trawl, veering to 1,900 fathoms of rope. It was up again at 1.03 P.M., the net containing a large number of specimens. [Station 2,095.]

The trawl was cast again at 2.44 P.M., in 1,451 fathoms, latitude 39° 22' 20" north, longitude 70° 52' 20" west. The bottom specimen brought up in the Sigsbee cup was the same as that of the former cast: but the trawl contained a granite stone weighing a hundred and seventy pounds, several small stones, small pieces of cinder, and lumps of hard clay; there were also several small specimens of what appeared to be oxidized iron. The haul was very successful, being particularly rich in foraminifera. [Station 2,096.]

As soon as the trawl was up, a set of serial temperatures and specific gravities was taken to 1,000 fathoms. A temperature of 66° was found at 25 fathoms, 65½° at 60 fathoms, and 57½° at 40 fathoms. These strata of cold and warm water are the rule rather than the exception, in this locality; but, thinking that possibly the observation at 40 fathoms had been read incorrectly, it was verified, using another instrument, which registered 55½°.

At 8.22 P.M. we started ahead south ½ west

<sup>1</sup> Report to Prof. S. F. BAIRD, U. S. commissioner of fish and fisheries, by Lieut.-Commander Z. L. TANNER, U.S.N., commanding U. S. fish-commission steamer, Albatross, kindly placed at our service by Professor Baird. Some of the appendices are abbreviated to save repetition.